

# PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

**PCT****NOTIFICATION OF ELECTION**

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents  
United States Patent and Trademark  
Office  
Box PCT  
Washington, D.C.20231  
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

<b>Date of mailing</b> (day/month/year) 29 June 2000 (29.06.00)	
<b>International application No.</b> PCT/EP99/08901	<b>Applicant's or agent's file reference</b> TS 0764 PCT
<b>International filing date</b> (day/month/year) 05 November 1999 (05.11.99)	<b>Priority date</b> (day/month/year) 06 November 1998 (06.11.98)
<b>Applicant</b> DIRKSE, Hendrik, Arien et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:  
17 May 2000 (17.05.00)

☐ in a notice effecting later election filed with the International Bureau on:  
\_\_\_\_\_

2. The election ☒ was

☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

<b>The International Bureau of WIPO</b> 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	<b>Authorized officer</b> C. Villet Telephone No.: (41-22) 338.83.38
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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference TS 0764 PCT	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP99/08901	International filing date (day/month/year) 05/11/1999	Priority date (day/month/year) 06/11/1998
International Patent Classification (IPC) or national classification and IPC C10G11/18		
Applicant SHELL INTERNATIONALE RESEARCH ... et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 6 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 17/05/2000	Date of completion of this report 02.02.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer  de Cauwer, R  Telephone No. +49 89 2399 7344 



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP99/08901

## I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:

### Description, pages:

1-8 as originally filed

### Claims, No.:

1-8 as originally filed

### Drawings, sheets:

1/2-2/2 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/EP99/08901

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes:	Claims 1-8
	No:	Claims

Inventive step (IS)	Yes:	Claims
	No:	Claims 1-8

Industrial applicability (IA)	Yes:	Claims 1-8
	No:	Claims

2. Citations and explanations  
**see separate sheet**

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**





**Re Item V**

**Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**Claim 1 - Novelty**

Claim 1 is a claim for a separator apparatus comprising a hollow circular housing connected to a dipleg, a gas outlet tube, an inlet means and a sieve.

The document D1: US-A-4 670 410 (BAILLIE LLOYD A) 2 June 1987 (1987-06-02) is regarded as being the closest prior art to the subject-matter of claim 1 and discloses (the references in parentheses applying to this document): an apparatus which accomplishes separation of solid catalyst particles from vapor (col 3, line 38-40) comprising an upright hollow circular housing (fig 2, ref 54 & col 4, line 2-3) connected to a dipleg (fig 1), a gas outlet (col 4, line 15) protruding co-axial from the top of the housing (fig 2), an inlet that is situated so that movement of the fluid stream mixture within the chamber causes solid particles to move in vortex fashion (col 4, line 50-51), and a plate (ref 121 & 134) having a plurality of holes (ref 124)(such a plate can be regarded as a sieve) positioned between the lower part of the circular housing and the upper part of the dipleg (fig 7 and 8). It is clear from fig 7 and 8 that the openings in the sieve are going to block particles exceeding 0.75 times the diameter of the dipleg, thus the sieve of D1 has openings which do not allow particles having a diameter greater than 0.75 times the diameter of the dipleg to pass the sieve and enter the dipleg.

The subject-matter of claim 1 therefore only differs from that known in the prior art D1 for the following reason: D1 does not disclose that the total area of openings in the sieve is greater than 2 times the cross sectional area of the dipleg. Thus the subject-matter of claim 1 can be regarded as novel (Article 33 (2) PCT).

**Claim 1 - Inventive Step**

The problem to be solved by the present invention may therefore be regarded as preventing the dipleg from clogging.

The solution to this problem proposed by the present application can then be regarded



as the provision of a sieve with a total area of openings greater than two times the cross sectional area of the dipleg.

The solution proposed in claim 1 of the present application cannot be considered as involving an inventive step (Article 33 (3) PCT) for the following reasons.

The problem to be solved seems to be already solved by the solution presented in D1 which also prevents clogging of the cyclone by means of a filter. The solution of the current application might still achieve a good separation efficiency but is actually just an alternative. In fact, the good separation efficiency has never been shown in the application. The necessary technical data has not been presented to show that the presented solution actually solves the problem or that an improvement over the prior art is obtained.

#### **Claim 2 - 7 - Novelty - Inventive Step**

Since claim 1 is novel, the dependent claims 2 - 7 also meet the requirements of Article 33 (2) PCT.

However, D1 further discloses a vortex stabilizer on top of the sieve (col 3, line 47-48 and fig 7 & 8) and an inlet means tangentially arranged at the upper part of the circular housing (fig 2 & 4).

Thus, the addition of these features to claim 1 would not render its subject-matter inventive.

#### **Claim 8 - Novelty**

Claim 8 is a claim for a fluid catalyst cracking process in which catalytic particles are separated from a gaseous reactor effluent in at least two sequential separation steps using an apparatus according to claims 1 -7.

The subject-matter of claim 8 is novel (Article 33 (2) PCT) over D1 for the same reasons as mentioned for claim 1.

#### **Claim 8 - Inventive Step**

D1 discloses a process for hydrocarbon cracking using solid catalyst particles where the catalytic particles are separated from an effluent (col 3, line 20-23) using two or



more separators as described before (col 4, line 66-68 - col 5, line 1-2).

Thus, for the same reasoning as put forth in claim 1, the subject-matter of claim 8 cannot be considered to involve an inventive step (Article 33 (3) PCT).

**Re Item VII****Certain defects in the international application**

To meet the requirements of Rule 5.1 a) ii) PCT, the document D1 should be identified in the description and the relevant background art disclosed therein should be briefly discussed.

The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).



## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>TS 0764 PCT</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/EP 99/ 08901</b>	International filing date (day/month/year) <b>05/11/1999</b>	(Earliest) Priority Date (day/month/year) <b>06/11/1998</b>
Applicant <b>SHELL INTERNATIONALE RESEARCH ... et al.</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

## 1. Basis of the report

- a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



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the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (see Box II).

## 4. With regard to the title,



the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

## 5. With regard to the abstract,



the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

## 6. The figure of the drawings to be published with the abstract is Figure No.



as suggested by the applicant.



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.

2



None of the figures.



1-1-1

1

1



## INTERNATIONAL SEARCH REPORT

International Application No

/EP 99/08901

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C10G11/18 B01J8/18 B04C5/14 B04C5/181

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C10G B01J B04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 670 410 A (BAILLIE LLOYD A) 2 June 1987 (1987-06-02) figures 2-8	1-8

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"Z" document member of the same patent family

Date of the actual completion of the international search

10 February 2000

Date of mailing of the international search report

22/02/2000

Name and mailing address of the ISA

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Authorized officer

Michiels, P



# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 99/08901

Patent document  
cited in search report

Publication  
date

Patent family  
member(s)

Publication  
date

US 4670410

A

02-06-1987

NONE



PCT

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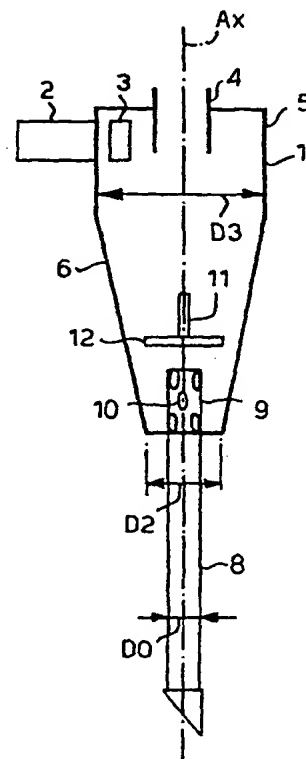
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : <b>C10G 11/18, B01J 8/18, B04C 5/14, 5/181</b>		A1	(11) International Publication Number: <b>WO 00/27949</b>
			(43) International Publication Date: 18 May 2000 (18.05.00)
(21) International Application Number: PCT/EP99/08901		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).	
(22) International Filing Date: 5 November 1999 (05.11.99)			
(30) Priority Data: 60/107,420 6 November 1998 (06.11.98) US			
(71) Applicant (for all designated States except US): SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V. [NL/NL]; Carel van Bylandtlaan 30, NL-2596 HR The Hague (NL).			
(72) Inventors; and		Published	
(75) Inventors/Applicants (for US only): DIRKSE, Hendrik, Arien [NL/NL]; Carel van Bylandtlaan 30, NL-2596 HR The Hague (NL). DRIES, Hubertus, Wilhelmus, Albertus [NL/NL]; Badhuisweg 3, NL-1031 CM Amsterdam (NL). STEIN, Louis, Edward [US/US]; 5818 Autumn Forest, Houston, TX 77092 (US).		With international search report.	

(54) Title: SEPARATOR APPARATUS

(57) Abstract

A separator apparatus for separating solids from a gas-solid containing feed resulting in a gas-rich stream, the separator comprising: an upright hollow circular housing fluidly connected to a dipleg for discharging solids positioned below the housing; a gas outlet tube for discharging the gas-rich stream from the circular housing, which outlet tube protrudes substantially co-axial from the top of the housing; inlet means for the gas-solids feed so arranged to create, in use, a vortex flow in the circular housing; and a sieve positioned between the lower part of the circular housing and the upper part of the dipleg, which sieve has openings which do not allow particles having a diameter greater than 0.75 times the diameter of the dipleg to pass the sieve and enter the dipleg and wherein the total area of the openings in the sieve is greater than 2 times the cross-sectional area of the dipleg.



*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

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EE	Estonia						

## SEPARATOR APPARATUS

Background of the invention

The invention is directed to a separator apparatus for separating solids from a gas-solid containing feed resulting in a gas-rich stream, the separator comprising:

5 an upright hollow circular housing fluidly connected to a dipleg for discharging solids positioned below the housing;

a gas outlet tube for discharging the gas-rich stream from the circular housing, which outlet tube protrudes  
10 substantially co-axial from the top of the housing;

inlet means for the gas-solids feed so arranged to create, in use, a vortex flow in the circular housing.

Such an apparatus is described in US-A-5391289. This patent publication describes a cyclone separator which is  
15 used as a secondary separation step to separate solid catalyst particles from the reactor effluent of a fluid catalytic cracking (FCC) reactor. In a FCC process hydrocarbons are cracked at high temperature in the presence of a solid catalyst to more desired components,  
20 for example gasoline and lower olefins. In the field of FCC these cyclone separators are also referred to as secondary cyclones. Other publications describing these secondary cyclones in a FCC process are for example US-A-5055177, US-A-5376339, EP-A-299650, EP-A-488549 and  
25 EP-A-309244.

A disadvantage of these secondary cyclones is that coke deposit may form on the walls of these apparatuses. Coke forming is a result of the hydrocarbons present in the feed to the cyclone and the relatively high  
30 temperatures of the gasses fed to the cyclones. Large pieces of coke can fall from the wall into the dipleg and

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cause to clog the dipleg. When a dipleg is clogged the cyclone will not function in an optimal manner as a solid-gas separator and the fluid catalytic cracking process will have to be shut down in order to remove the coke from the dipleg. Because FCC processes are expected to run many months and even years between planned shutdowns any unexpected shutdown will cause considerable economic damage.

The object of this invention is to avoid the problems associated with clogging of the diplegs of the separator apparatus.

#### Summary of the invention

The object is achieved by the following apparatus. A separator apparatus for separating solids from a gas-solid containing feed resulting in a gas-rich stream, the separator comprising:

an upright hollow circular housing fluidly connected to a dipleg for discharging solids positioned below the housing; a gas outlet tube for discharging the gas-rich stream from the circular housing, which outlet tube protrudes substantially co-axial from the top of the housing, inlet means for the gas-solids feed so arranged to create, in use, a vortex flow in the circular housing; and a sieve positioned between the lower part of the circular housing and the upper part of the dipleg, which sieve has openings which do not allow particles having a diameter greater than 0.75 times the diameter of the dipleg to pass the sieve and enter the dipleg and wherein the total area of the openings in the sieve is greater than 2 times the cross sectional area of the dipleg.

It has been found that when such a sieve is used less problems due to clogging of the dipleg occur. Because of the sieve a reduction of the normal swirl movement in the dipleg is observed. As a result the pressure difference per length of dipleg will increase making it possible to



use a shorter dipleg. This is very advantageous,  
especially when these cyclones are present within a  
vessel, for example a stripping vessel of a FCC process.  
The length of a dipleg is often the determining factor  
for the dimensions of the vessel. Thus shorter diplegs  
result in that smaller vessels can be employed.

#### Brief description of the drawings

The invention shall be further elucidated by means of  
the following figures. Figure 1 represent a vertical  
cross section of the separator apparatus according the  
invention. Figure 2 represents another embodiment of the  
invention, wherein the lower part of the housing is not  
present. Figure 3 represents a possible embodiment for a  
sieve combined with a vortex stabiliser. Figure 4  
represents the upper part of a stripping vessel of a FCC  
process.

#### Detailed description of the invention

Preferably the openings of the sieve do not allow  
particles greater than 0.5 times the diameter ( $D_0$ ) of the  
dipleg to pass the sieve.

Preferably the total area ( $A_0$ ) of the openings of the  
sieve is greater than 5 times the cross sectional area  
( $A_1$ ) of the dipleg.

The circular housing of the separator may suitably  
have an upper tubular portion with a diameter ( $D_3$ ), a  
conical formed housing as a middle portion of which  
smaller diameter ( $D_2$ ) is at the lower end and optionally  
a lower part having a diameter ( $D_1$ ) which is greater than  
the diameter ( $D_2$ ) of the lower part of the conical  
housing. The diameter ( $D_0$ ) of the dipleg is suitably  
smaller than the diameter ( $D_3$ ) of the upper part of the  
circular housing of the separator. Preferably the volume  
of the circular housing at the level where the sieve is  
located is sufficiently large to allow coke particles to  
accumulate. The dimensions of the sieve will be so chosen

that while coke particles accumulate in the lower part of the housing a sufficiently large number of openings are not blocked in order to allow the separated particles to enter the dipleg. The form of the holes is not very critical. Circular, rectangular holes and slots are possible forms for the openings in the sieve.

The sieve is preferably positioned symmetrically around the axis just on top of the inlet opening of the dipleg. One embodiment of the invention is where the sieve is a tube placed on top of the dipleg which tube protrudes the circular housing from below. The tube has about the diameter of the dipleg and has an open lower end and a closed upper end. In the vertical walls of the tube holes are present.

The sieve is preferably sufficiently strong to avoid it being damaged by erosion due to the gas-solids moving in the circular housing. Protective linings can be applied to protect the upper part of the sieve. A more preferred method of protecting the sieve is by positioning a vortex stabiliser below the opening of the gas outlet tube and above the sieve. The vortex, present in use, will end at the top of the vortex stabiliser thereby reducing erosion of the sieve. The vortex stabiliser will additionally further reduce any swirl movement in the dipleg and thus increases the pressure difference per length of dipleg, which is advantageous for the reasons set out earlier.

The vortex stabiliser comprises suitably of a hat having a relatively large diameter and a vertically oriented vortex stabiliser rod placed on top of the hat having a considerably smaller dimension relative to the hat. The hat may be for example a circular plate or a cone. When a cone is used the top of the cone may function as a vortex stabiliser rod. Vortex stabilisers

- 5 -

are also described in for example US-A-4692311, EP-A-360360 and EP-A-220768.

A preferred embodiment is where the vortex stabiliser is placed on top of the sieve.

5       The vortex stabiliser may have a hollow tube as vortex stabiliser rod, wherein a fluid connection is present via the hollow tube between the top of the vortex stabiliser and a position below the vortex stabiliser and above the inlet of the dipleg.

10       The inlet means for the gas-solids feed can be axially or tangentially arranged at the upper tubular part of the circular housing.

15       The apparatus is preferably used as the second separation step (also referred to as secondary cyclone) to separate catalyst particles from a gaseous reactor effluent of a fluid catalyst cracking process in which the separation is conducted in at least two sequential separation steps.

20       A fluid catalytic cracking process comprises a reactor in which catalyst particles and gaseous hydrocarbons are contacted. The reactor is generally a vertically positioned tubular reactor often referred to as the riser reactor through which catalyst and reactants co-currently flow in an upwards direction. At the end of  
25       the riser the catalysts are separated from the reactor effluent. This separation is usually effected by means of one or more cyclones. The thus separated catalysts are collected in a stripping vessel. In this vessel the catalysts are stripped with a water containing gas to  
30       separate any hydrocarbons from the catalyst. The stripped catalysts are subsequently send to a regenerator vessel in which any coke is removed from the catalyst by means of combustion. The stripped and regenerated catalyst is reused in the process.

The separation of catalyst from the reactor effluent is suitably performed by means of a first separator which separates the bulk of the catalyst, followed by a secondary cyclone which separates most of the remaining catalyst particles. Depending on the specific layout more than one secondary cyclone may be present operating parallel and/or in series of each other. These separator means may be placed inside the stripping vessel or outside the stripping vessel. Combinations of the two are also possible, wherein the primary separation means is placed inside the stripping vessel and the secondary cyclone is placed outside the stripping vessel. The advantages of the invention are especially apparent when the secondary cyclone is placed inside the stripping vessel because these cyclones cannot be easily inspected when the FCC process is in operation. Examples of such FCC configurations are described in the earlier cited patent publications US-A-5055177, US-A-5391289, EP-A-309244 and EP-A-299650. If the secondary cyclone is placed inside the stripping vessel the gas-solids feed inlet is preferably tangentially arranged.

Preferably both the primary separation means, suitably a cyclone also referred to as the rough cut cyclone, and the secondary cyclone are placed inside the stripping vessel. More preferably the gas outlet of the rough cut cyclone is in fluid connection with the inlet of the secondary cyclone. This is advantageous because the residence time of the cracked hydrocarbons after they leave the reactor riser in the different separation means is hereby reduced so as to avoid non-controlled cracking also referred to as after cracking. In order to have an outlet means for the stripping gases in the stripping vessel an opening is present in the conduit between the rough cut cyclone and the secondary cyclone. Preferably this opening is effected by a slit.

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In Figure 1 a separator apparatus according the invention is shown having a hollow circular housing (1), symmetrical around an axis (Ax), fluidly connected to a dipleg (8) a gas outlet tube (4), inlet means (3) for the gas-solids feed, tangentially arranged to create, in use, a vortex flow in the circular housing (1). The inlet means (3) is fluidly connected to an inlet conduit (2). The circular housing (1) has upper tubular portion (5) with a diameter (D3), a frusto-conical envelope as a middle portion (6) of which smallest diameter (D2) is at the lower end and a lower part (7) having a diameter (D1). A tubular sieve (9) with circular openings (10) covers the inlet of the dipleg (8). Also shown is a vortex stabiliser (11) positioned on a hat (12).

In Figure 2 the numbers have the same meaning as in Figure 1. The embodiment disclosed in Figure 2 differs from the one disclosed in Figure 1 in that no widened lower part of the housing is present.

In Figure 3 a tubular sieve (9) is shown with rectangular openings (10) covering the inlet of the dipleg (8) placed in the lower part (7) of the housing. On top of the sieve a vortex stabiliser (11) is positioned. The hat (12) of the vortex stabiliser forms the top of the tubular sieve (9).

Figure 4 represents a preferred stripping vessel (16) of a FCC process having a secondary cyclone according the invention. The upper part of the stripping vessel is shown in which a reactor riser (17) is fluidly connected to a rough cut cyclone (18), which rough cut cyclone is fluidly connected with a gas outlet conduit (19). In the horizontal part of this conduit (19) a slit (21) is present. Conduit (23) is in fluid connection with the tangentially arranged inlet of the secondary cyclone (24). The secondary cyclone (24) has a tubular sieve (25) covering the inlet of the dipleg (26). The

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gaseous product poor in catalyst particles leave the secondary cyclone and the stripping vessel via conduit (27). The lower part of the stripping vessel comprises a fluid bed of catalyst particles (28) to which stripping gas is supplied to via inlet means (29). The dipleg (26) of the secondary cyclone ends about at the upper level of the fluidized bed (28) and the dipleg of the rough cut cyclone (30) ends within the fluidized bed (28). Through the slit (21) stripping gases can enter the inlet of conduit (23) and leave via the secondary cyclone (24) the stripping vessel (16).

C L A I M S

1. A separator apparatus for separating solids from a gas-solid containing feed resulting in a gas-rich stream, the separator comprising:

an upright hollow circular housing fluidly connected  
5 to a dipleg for discharging solids positioned below the housing;

a gas outlet tube for discharging the gas-rich stream from the circular housing, which outlet tube protrudes substantially co-axial from the top of the housing;

10 inlet means for the gas-solids feed so arranged to create, in use, a vortex flow in the circular housing;

and a sieve positioned between the lower part of the circular housing and the upper part of the dipleg, which sieve has openings which do not allow particles having a  
15 diameter greater than 0.75 times the diameter of the dipleg to pass the sieve and enter the dipleg and wherein the total area of the openings in the sieve is greater than 2 times the cross sectional area of the dipleg.

2. Apparatus according to claim 1, wherein the openings  
20 of the sieve do not allow particles greater than 0.5 times the diameter of the dipleg to pass the sieve.

3. Apparatus according to any one of claims 1-2, wherein the total area of the openings of the sieve is greater than 5 times the cross sectional area of the dipleg.

25 4. Apparatus according to any one of claims 1-3, wherein a vortex stabiliser is positioned co-axial to the central axis below the opening of the gas outlet and above the sieve.

5. Apparatus according to claim 4, wherein the vortex  
30 stabiliser is placed on top of the sieve.

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6. Apparatus according to any one of claims 1-5, wherein the inlet means for the gas-solids feed are tangentially arranged at the upper part of the circular housing.

7. Apparatus according to any one of claims 1-6, wherein the sieve is a tube placed on top of the dipleg which tube protrudes the circular housing from below, has about the diameter of the dipleg, has an open lower end and a closed upper end and holes are present in the vertical walls of the tube.

8. Fluid catalyst cracking process in which catalyst particles are separated from a gaseous reactor effluent in at least two sequential separation steps, wherein the apparatus according to any one of claims 1-7 is used in the second step.



Fig.1.

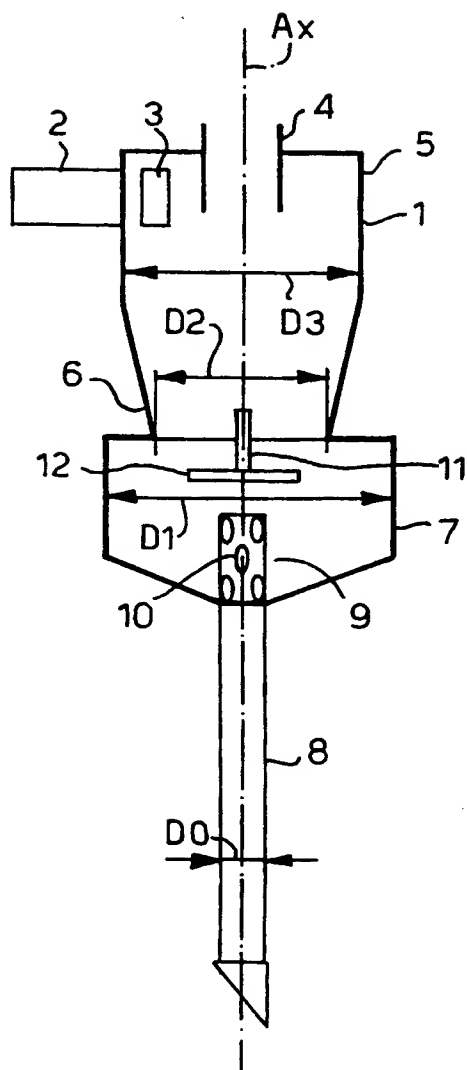
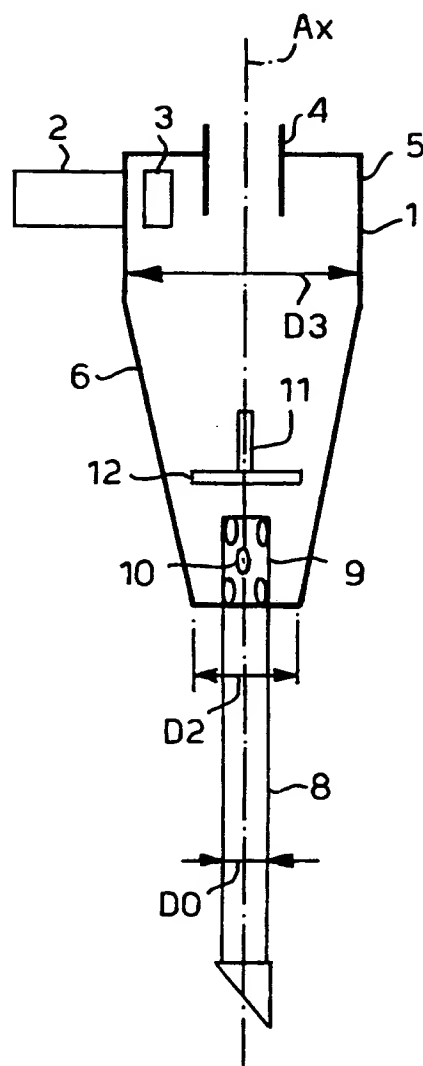


Fig.2.





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Fig.3.

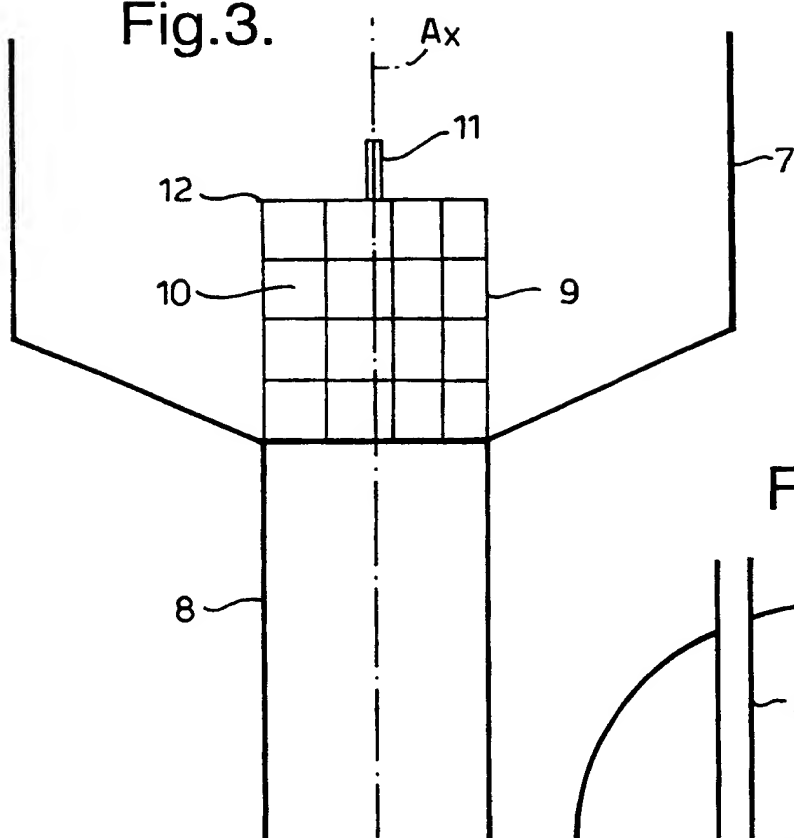


Fig.4.

